

**MEMORANDUM REPORT VRTC-DCD-6102
EA05-022**

Investigation of Front Seatbelt Buckle Malfunction in 2002 Jeep Liberty Vehicles

1.0 Introduction

This program was performed at the Vehicle Research and Test Center (VRTC) at the request of the Office of Defects Investigation (ODI) of the National Highway Traffic Safety Administration. ODI opened an Engineering Analysis (EA05-022) on 2002 Jeep Liberty vehicles, manufactured by DaimlerChrysler Corporation (DCC), to investigate consumer complaints to ODI alleging various problems in the front seatbelt buckles. The subject buckles are an end release type manufactured by TRW. Five Complaint Buckles were provided to VRTC by ODI. Four of these had been obtained by ODI personnel from owners who had submitted Vehicle Owner Questionnaires (VOQ) alleging that the buckles were not functioning properly. The remaining buckle was obtained by ODI personnel from an owner who had submitted a complaint to DCC. One new exemplar buckle was purchased by VRTC and was examined in order to provide a comparison to the complaint buckles.

2.0 Objective

The objective of this program was to verify and identify the existence and source of any impairment that affected the complaint buckles' ability to latch or unlatch, or that caused the buckles to false latch.

3.0 Inspections

Examinations of the new exemplar buckle and the five complaint buckles are described below. The condition and operation of each buckle, including determining the force required to activate the release mechanism, was documented in the as-received condition. The force required to activate the release mechanism for each buckle and the VOQ reference number for each buckle, where applicable, are shown in Table 1. Following the initial inspection, each buckle was opened by using a small rotary tool (Dremel) equipped with a very narrow abrasive cut-off wheel to carefully cut along the edge of the outer buckle housing until the two halves of the housing could be separated. Great care was taken to prevent damage to any of the interior parts of the buckles during the process of opening the buckle case.

Table 1
Buckle Identification and Release Forces

	Buckle #1	Buckle #2	Buckle #3	Buckle #4	Buckle #5	Exemplar
VOQ No.	10153934	10138334	10149639	10152705	N/A	N/A
Release Force (lb)	1.6	1.5	1.7	1.5	1.6	3.0

TRW information states “The latch guide portion of the buckle (P/N 33008996) guides the latch during latching and unlatching operation. The latch guide provides force by means of two integral leaf springs to aid push button return.” The two cross-sectional areas where the leaf springs attach to the latch guide were measured to be less than 0.006 square inches each. Detailed descriptions of the five subject buckles are provided below. TRW’s description of the buckle is provided in Appendix I.

The exemplar buckle was opened first and set aside for later comparison to the subject buckles. As each subject buckle was opened, it became apparent that each exhibited the same failure mode. Both leaf springs on all five subject buckles were found to have detached from the latch guide. The leaf springs were loose in some of the buckles, missing in some of the buckles, and wedged under a sliding piece in one of the buckles.

Figure 1 shows a side-by-side comparison of the interior of the intact exemplar buckle and the area of the missing leaf springs of a subject buckle. Figure 2 shows a close-up of one of the leaf springs in the exemplar buckle. Figure 3 shows the corresponding area of a subject buckle with the leaf spring missing.

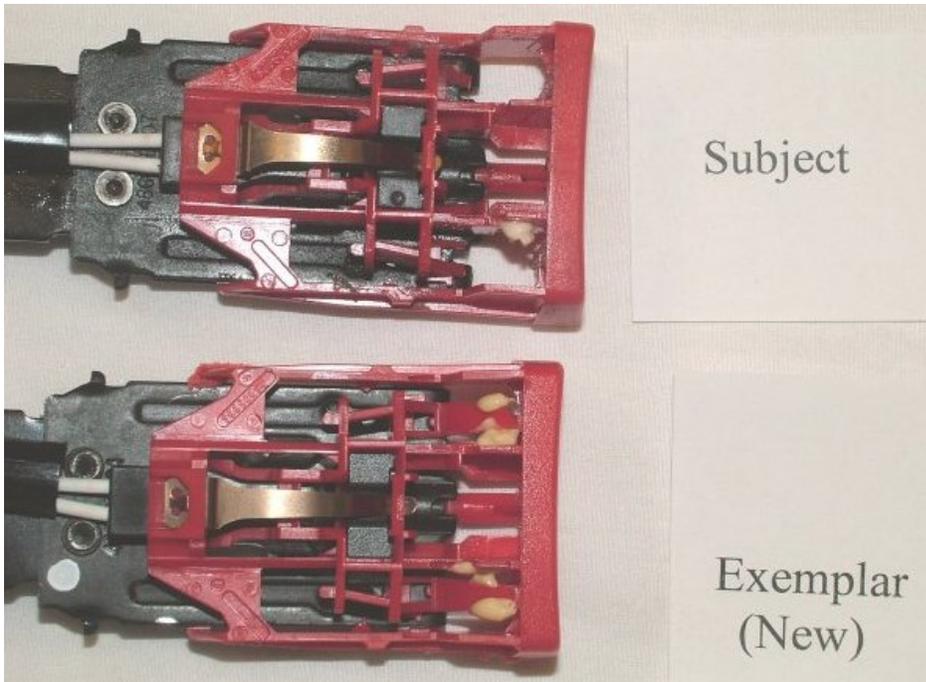


Figure 1
Side-by-Side Comparison of Subject and Exemplar Buckles (Note Missing “Spring” Pieces Directly behind Button on Subject Buckle)

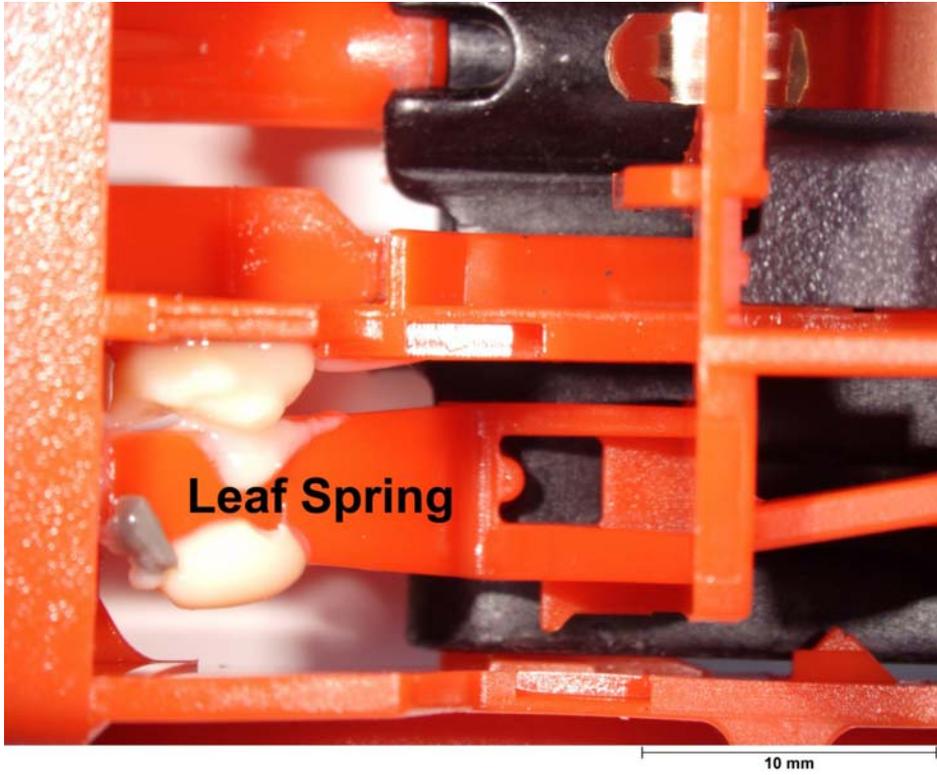


Figure 2
Exemplar Buckle
Leaf Spring as
Manufactured
(One of Two)

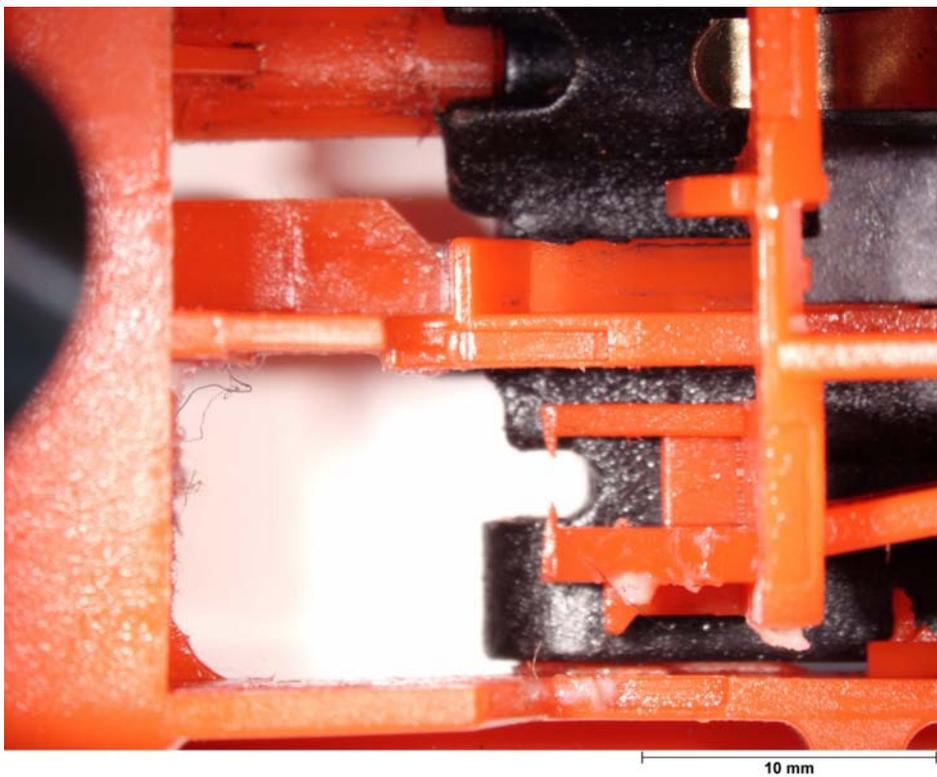


Figure 3
Area of Missing
“Spring” and
Fracture Surface on
Complaint Buckle
(Typical)

3.1 Buckle #1

Mileage from VOQ: 60,250. Complaint from VOQ: “The seatbelt latch button becomes stuck in the down position after the seatbelt is released. The button must then be manually pulled up before buckling the seatbelt again. I have noticed a piece of broken red plastic within the assembly.”

As received at VRTC, the release button was stuck in the depressed position. Lightly tapping the buckle with one finger caused the button to return to the normal (non-depressed) position. The buckle would usually not latch until greater-than-normal force was exerted on the latch plate. Once latched, the buckle appeared to hold properly. When the button was depressed in an effort to release the latch plate, the latch plate was ejected but the button remained depressed. After opening the buckle housing, both leaf springs were found to be detached. One of the broken leaf springs fell out when the housing was opened. The other spring was not located. One side of the latch guide was found to be fractured. After the loose piece fell out, the function of the buckle returned to normal except that the latch guide was observed to move briefly upward as the latch plate was ejected. The button returned to the normal expected position after release of the latch plate. Figures 4 and 5 show the fractured latch guide. Figure 6 shows the loose leaf spring. Figure 7 shows the position of the release button as received.

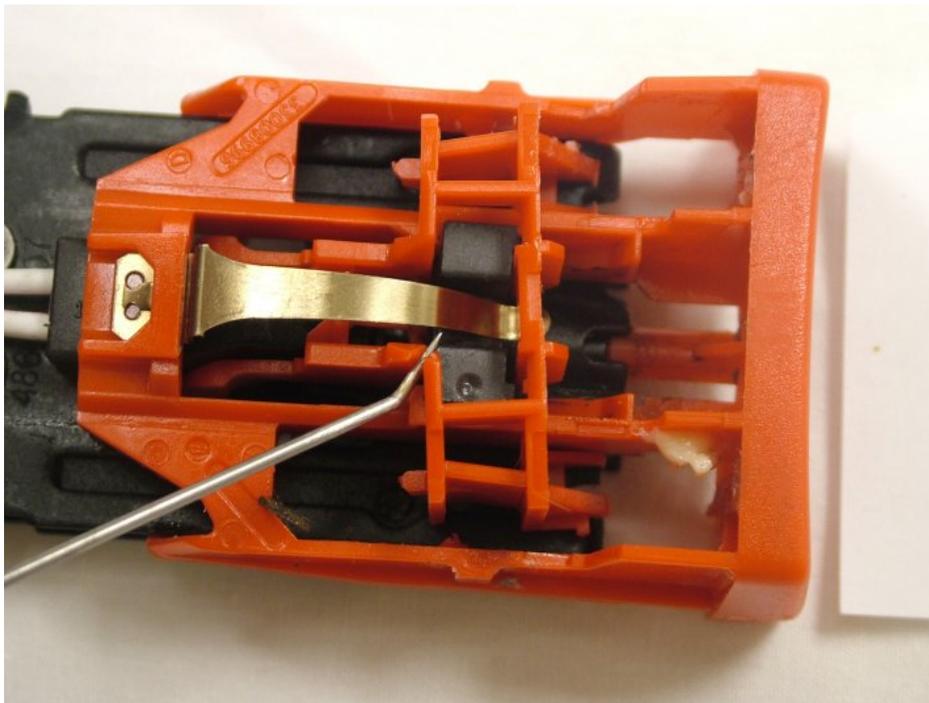


Figure 4
Fractured
Latch Guide

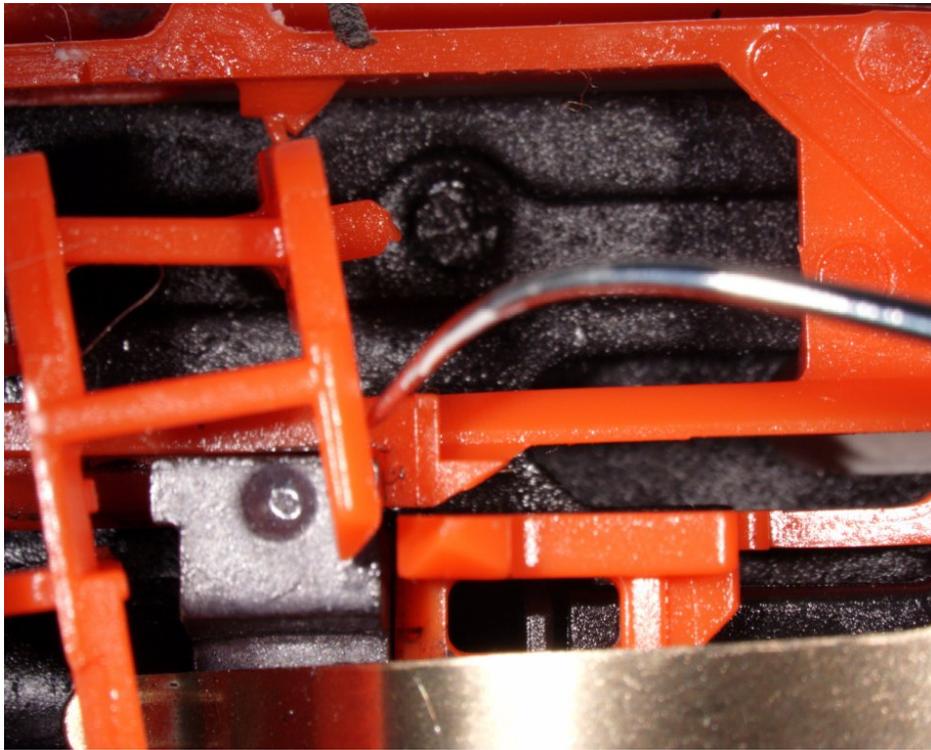


Figure 5
Close-Up of
Fractured Latch
Guide



Figure 6
Loose
Leaf Spring



Figure 7
Release Button as Received

3.2 Buckle #2

Mileage from VOQ: 49,000. Complaint from VOQ: “The driver’s seatbelt does not clip into the female portion of the mechanism. The red release button stays depressed not being able to re-accept the male portion of the mechanism.”

As received, the buckle appeared normal and would latch with ordinary force. Once latched, the buckle appeared to hold properly. When the button was depressed to release the latch plate, the latch plate was ejected and there was a slight delay before the button returned to the unlatched position. After opening the buckle housing, fibrous foreign material was found on the internal parts of the buckle, including the loose leaf springs. Both leaf springs were found to be detached. One of the broken leaf springs fell out when the housing was opened. After the loose piece fell out, the button remained in the depressed position after the latch plate was ejected. Slight pressure on the bottom of the button caused it to return to the normal position. The latch guide was observed to move briefly upward as the latch plate was ejected.

Figure 8 shows the loose leaf spring. Figure 9 shows the release button as received. Figure 10 shows foreign material on the loose leaf spring.



Figure 8
Loose
Leaf Spring



Figure 9
Release Button as
Received

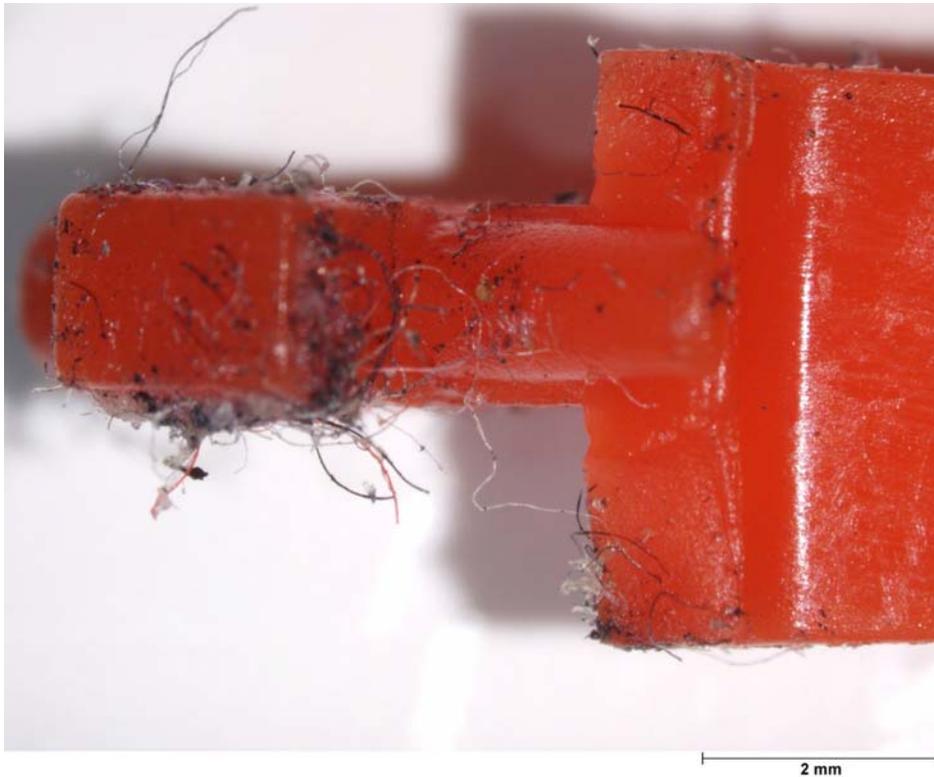


Figure 10
Foreign Material on
Broken Leaf Spring

3.3 Buckle #3

Mileage from VOQ: 38,000. Complaint from VOQ: “Driver’s seatbelt buckle button (is) stuck. Unable to use seatbelt.”

As received, the button was stuck in the depressed position and would not move. The latch plate could be inserted but the buckle would not engage the latch plate. After opening the buckle housing, both leaf springs fell out. One of the leaf springs was in two pieces and appeared to have been sheared. Some foreign material was found within the buckle. After the leaf springs fell out, the function of the buckle returned to normal except that the latch guide was observed to move briefly upward as the latch plate was ejected. The button returned to the normal expected position after release of the latch plate.

Figure 11 shows the two loose leaf springs. Figure 12 shows the shear location on the broken leaf spring. Figure 13 shows the release button as received. Figure 14 shows the location on the leaf spring where it detached from the latch guide.



Figure 11
Two Loose Leaf Springs

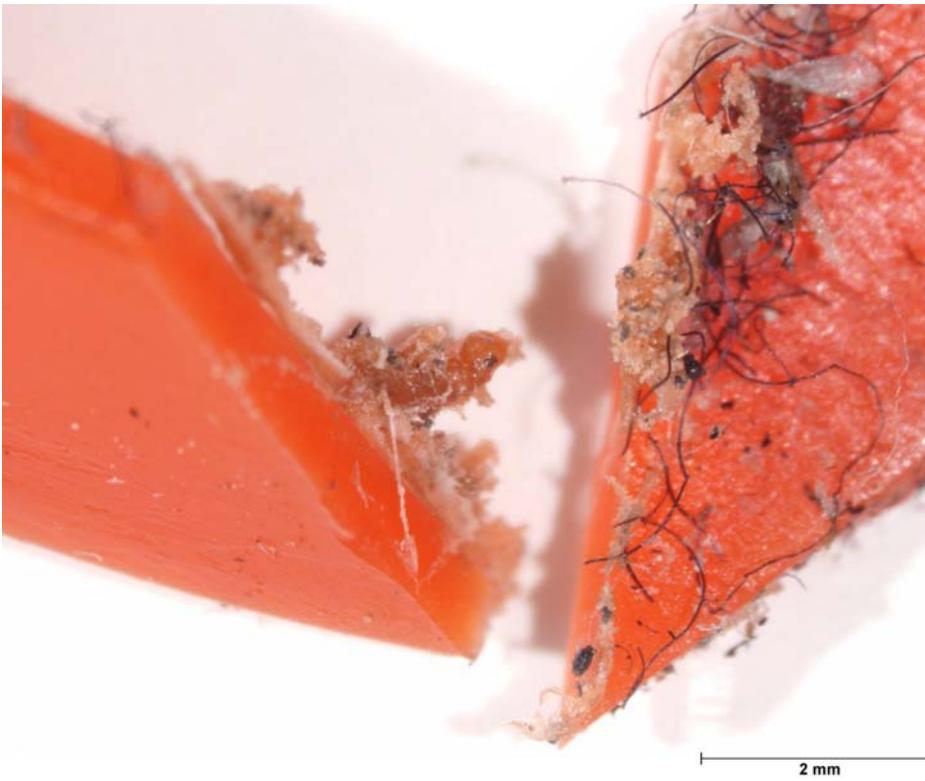


Figure 12
Shear Location on Leaf Spring



Figure 13
Release Button as
Received

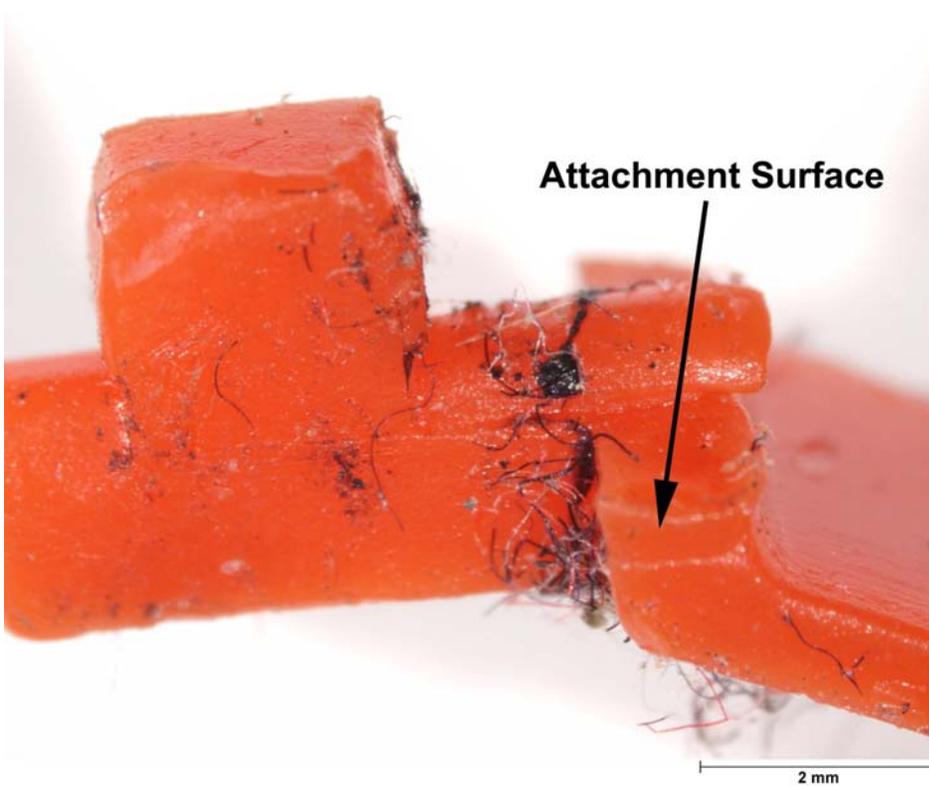


Figure 14
Leaf Spring
Attachment Surface
to Latch Guide

3.4 Buckle #4

Mileage from VOQ 56,617. Complaint from VOQ: “Front drivers side seatbelt stuck with pushbutton down; will not lock.”

As received, the release button was in the depressed position. Lightly tapping the buckle caused the button to return to the normal (non-depressed) position. The buckle latched with ordinary force. Once latched, the buckle appeared to hold properly. When the button was depressed to release the latch plate, the latch plate was ejected but the button remained depressed. After opening the buckle housing, both leaf springs were found to be detached (neither was present) and the operation of the buckle remained the same as the as-received condition. The latch guide was observed to move briefly upward as the latch plate was ejected.

Figure 15 shows the release button as received.



Figure 15
Release Button as
Received

3.5 Buckle #5

Mileage: unreported. No accompanying complaint was provided. As received, the buckle appeared normal and would latch with ordinary force. Once latched, the buckle appeared to hold properly. When the button was depressed to release the latch plate, the latch plate was ejected but the button remained depressed. After opening the buckle housing, both leaf springs were

found to be detached and both were present. The right leaf spring was loose and fell out when the housing was opened. The left leaf spring was found wedged under the rear (lower) part of the sliding button. After the loose piece fell out, operation of the buckle remained the same as the as-received condition except that sometimes the button would return to the normal (non-depressed) condition and sometimes it would remain depressed. When the button remained depressed, slight pressure on the bottom of the button caused it to return to the normal position. The latch guide was observed to move briefly upward as the latch plate was ejected.

Figure 16 shows the loose leaf spring wedged under the latch guide. Figure 17 shows the release button as received.



Figure 16
Loose Leaf Spring
Wedged Under
Latch Guide



Figure 17
Release Button as
Received

3.6 Loose Piece in Packing Material

One of the broken leaf springs was found loose in the packing material that the buckles were shipped in from ODI to VRTC. The source buckle is unknown except that it could not have been buckles 3 or 5 because both of the leaf springs in both of these buckles were still present. Of the remaining three buckles, it is suspected that this loose leaf spring came from Buckle #2 because of the foreign material present on the loose spring. Figure 18 shows the leaf spring that was found loose in the shipping package.



Figure 18
Loose Leaf Spring
Found in Packing
Material

4.0 Discussion

The attachment surface of the leaf springs to the latch guide is very small ($<.006 \text{ in}^2$ each). Both of the leaf springs had separated from the latch guide in all five of the subject buckles that were inspected. Random positioning of the loose leaf springs may cause random faulty operation of the buckle for a number of reasons, depending on the location of the loose leaf spring at any given time. Some of the problems discovered during these inspections include:

- One leaf spring had exited the buckle during shipment to VRTC and was found loose in the packing material of the box that the buckles were shipped in. This occurrence suggests that the loose leaf springs are free to move about within the buckle housing.
- One leaf spring was found wedged between the base and the latch guide. This condition may contribute to faulty operation of the buckle.
- One leaf spring was found to have sheared into two pieces. This occurrence suggests that the loose leaf springs are capable of migrating into areas within the buckle that can increase the force required to operate the buckle or possibly inhibit operation until the loose spring is severed or dislodged.

Appendix I
Buckle Head Assembly – Exploded View and Component Function

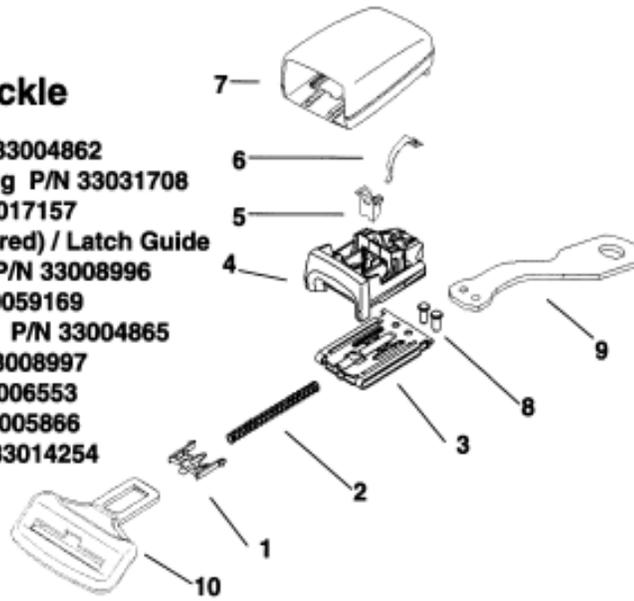
TRW RNS-3G Buckle Head Assemblies

General Buckle Function Descriptions requested
by NHTSA

RNS-3G Buckle Head Assembly – Exploded View

RNS-3G Buckle

1. Ejector P/N 33004862
2. Ejector Spring P/N 33031708
3. Base P/N 33017157
4. Pushbutton (red) / Latch Guide (magenta) P/N 33008996
5. Latch P/N 00059169
6. Latch Spring P/N 33004865
7. Cover P/N 33008997
8. Rivet P/N 33006553
9. Strap P/N 33005866
10. Tongue P/N 33014254



RNS-3G Buckle Head Assembly – Component Function

1. Ejector P/N 33004862

- Houses magnet which causes Hall sensor to change state and signal vehicle control module as to whether the buckle is in the latched or unlatched state.
- Transfer movement to the push button from the action of inserting the tongue to initiate latching of the buckle assembly.
- Transfers force from the ejector spring to the tongue to eject the tongue from the buckle during unlatching.
- Transfers force from the ejector spring to the push button to aid push button return in the unlatched state.
- Provides a positive stop by means of the base to limited travel of the tongue into the buckle.
- Prevents latch from falling when the push button is depressed with no tongue in the buckle.

3

TRW

RNS-3G Buckle Head Assembly – Component Function

2. Ejector Spring P/N 33031708

- Provides force by means of the ejector to eject the tongue from the buckle during unlatching.
- Provides force by means of the ejector to aid push button return in the unlatched state.

3. Base P/N 33017157

- Provides foundation for buckle assembly to which all other components are mounted.
- Provides means to attach buckle assembly to “system level” structural attachment components, i.e.: webbing, strap, bracket, etc.
- Structural component transferring tensile forces from tongue to latch to system level structural components.

4

TRW

RNS-3G Buckle Head Assembly – Component Function

4A. Pushbutton P/N 33008996

- Guides latch during latching / unlatching operation.
- Disengages latch from latched position by means of force applied by occupant to the face of the push button.
- Supports latch spring for engaging and disengaging latch
- Acts as lead-in for tongue insertion.

4B. Latch Guide P/N 33008996

- Guides latch during latching / unlatching operation.
- Provides force by means of integral leaf springs to aid push button return in the latched and unlatched state.

5

TRW

RNS-3G Buckle Head Assembly – Component Function

5. Latch P/N 00059169

- Structural component transferring tensile forces from tongue to base.
- Facilitates latching / unlatching of the buckle.

6. Latch Spring P/N 33004865

- Provides force to drive latch to engage base and tongue during latching operation.
- Aids return of push button in the latched state.

6

TRW

RNS-3G Buckle Head Assembly – Component Function

7. Cover P/N 33008997

- Houses buckle assembly.
- Has features to help guide tongue into buckle at the tongue opening.
- Protects internal components.

8. Rivet P/N 33006553

- Provide structural attachment of system level hardware (straps) to base.

9. Strap P/N 33005866

- Provide structural attachment of buckle to vehicle structure.